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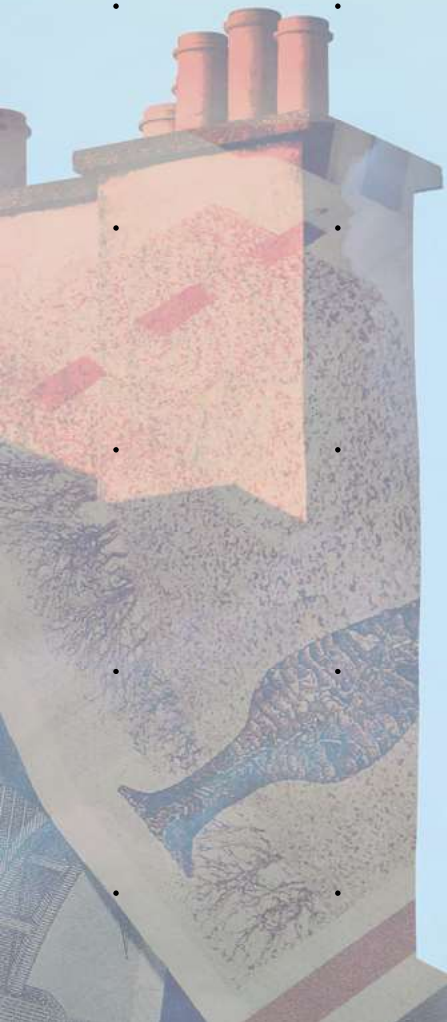
Financing the Green Transition



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Although the financing for green investments has increased in recent years, more financing is needed than what is provided on market terms. This is due to various market failures. The most important policy tools to boost green investment financing are CO_2e taxes and emission permits. In addition, sustainable finance can contribute. We describe what policy tools authorities can use to promote sustainable finance and what role Danmarks Nationalbank plays in this. The main contribution of Danmarks Nationalbank is to ensure stable economic and financial conditions that support long-term planning and investment in the transition.

Recent years have seen an increase in weather-related natural disasters, underscoring the importance of the green transition. The economic literature on climate change finds that it is less costly over the long run to mitigate climate change than to adapt to its consequences. A global green transition today would therefore spare the planet substantial economic and human costs in the future.[1,2] Denmark cannot take on this challenge alone, as our emissions account for only a small share of the global emissions. Nevertheless, Denmark can promote the transition globally by taking the lead, developing solutions and inspiring other countries to transition. How we decarbonise in Denmark is therefore paramount.

The Council on Climate Change plays a crucial role in the debate on how Denmark should achieve its climate objectives. The Council provides high-quality input to Danish climate policymaking. This is something that affects all of us. At Danmarks Nationalbank, we have closely monitored the Council's analyses and recommendations, incorporating them into our work to assess the impact of the green transition on the Danish economy.[3] We extend our warm congratulations to the Council on its anniversary and thank them for their efforts to create a more sustainable future!

Our contribution to this anniversary publication offers perspectives on two topics: sustainable finance and Danmarks Nationalbank's climate-related work. We focus on sustainable finance because the green transition requires substantial investments, which must be financed, and because Danmarks Nationalbank is at the centre of Denmark's financial system. In addition, climate change and the green transition affect our objectives of stable prices and financial stability in Denmark.

Market failures inhibit the green transition

Market forces alone cannot deliver the green transition, as the problem of greenhouse gas emissions (CO_2e) arises from market failures. Market failures occur when free market mechanisms do not lead to a socially optimal allocation of resources and distribution of activity, in this case CO_2e emissions. In this section, we outline key climate-related market failures and explain why CO_2e taxes and emission permits are the most important policy tools for achieving a cost-effective transition. In the following sections, we turn to sustainable finance as a complementary, albeit secondary, policy tool for addressing market failures.[4]

Consumers and firms do not pay for climate costs when emitting

Despite climate objectives being adopted in many countries, global emissions continue to rise. This is partly due to increasing consumption of fossil fuels, see Figure 1. In Denmark, we have managed to reduce emissions from domestic production, but we are still a long way from meeting the 2050 climate neutrality target set out in the Climate Act. Moreover, Denmark's consumption-based emissions have not declined at the same pace as its production-based emissions, reflecting increased emissions from products produced abroad and consumed in Denmark.[5]

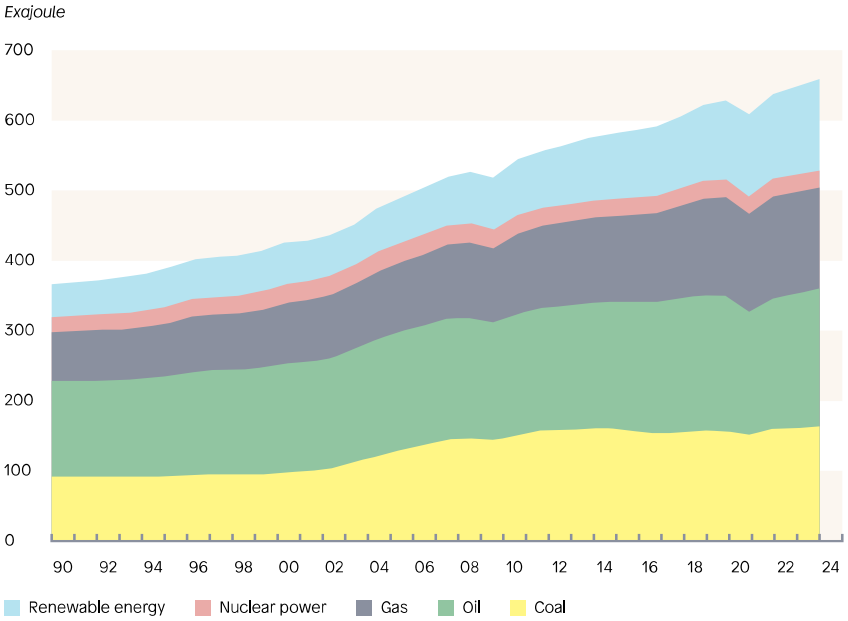

Figure 1 Global energy consumption continues to rise

Note 1: The figure shows global annual energy consumption across primary sources.

Sources: Macrobond.

The fundamental climate-related market failure is the externality of emissions: consumers and firms do not pay for the emissions caused by their consumption and production choices, even though these emissions impose costs on the global com-

munity in the form of climate change. The absence of a price on emissions implies that global emissions are above the optimal level when trading off the benefits and costs of emitting at a global scale.

The best solution to this market failure is to tax emissions. Notable examples of CO_2e taxation include Denmark's CO_2e taxes and the EU Emissions Trading System. When taxes and emission permits raise the price on emissions, the goods and services that generate emissions become more expensive, dissuading consumers from choosing them and encouraging a shift towards greener consumption. At the same time, taxes and emission permits help prevent firms that invest in green technology from being outcompeted due to the associated higher costs of green technologies.

However, schemes that attach a significant price tag to emissions remain limited in scope and effect. This is reflected in the average global price of emissions, which is approximately USD 6 per tonne of CO_2e. For comparison, the IMF estimates that a price of USD 75 will be necessary by 2030 at the latest to limit global warming to below 2 °C above the pre-industrial level.[6] At the same time, fossil fuels – and thus the cost of emitting – remain heavily subsidised, with global subsidies amounting to approximately USD 7,000 billion, or 7.1 per cent of GDP, in 2022.[7]

Financial market failures inhibit the financing of green investments

According to the European Commission, 764 billion euros were invested in the green transition on average each year in the EU in 2011–2020, see Figure 2. This represents 5.1 per cent of the EU's GDP in 2023. The amount comprises public and private investments, with approximately three-quarters of the investments being made in transport.[8]

The Commission estimates that investments in the green transition must increase by EUR 477 billion annually, equivalent to 3.2 per cent of the EU's GDP by 2023, if the EU is to meet its 55 per cent reduction target by 2030. The majority of the additional investments are needed in green transport and energy renovation of buildings. Additionally, the need for investment increases further if climate adaptation is factored in. Similar conclusions are presented in the Draghi Report, which, among other things, asserts that the transition is crucial for the EU's competitiveness, as it can provide the EU with a leading position in green technologies and reduce dependence on external energy sources.[9] Although there is uncertainty around the estimates of the investment need, and while other organisations

mention different figures, this does not change the main conclusion: the transition requires massive amounts of additional investments.[10]

Investments by consumers, firms and the public sector into green consumption and production require financing. Financing of private investments typically comes from household and firm savings, which are channelled through banks, pension funds and other financial institutions in the form of loans and capital contributions into investment projects domestically and abroad. Financial commitments are usually based on an assessment of expected return, risk and time horizon of the investments. In Denmark, savings levels are high, so there is gene-

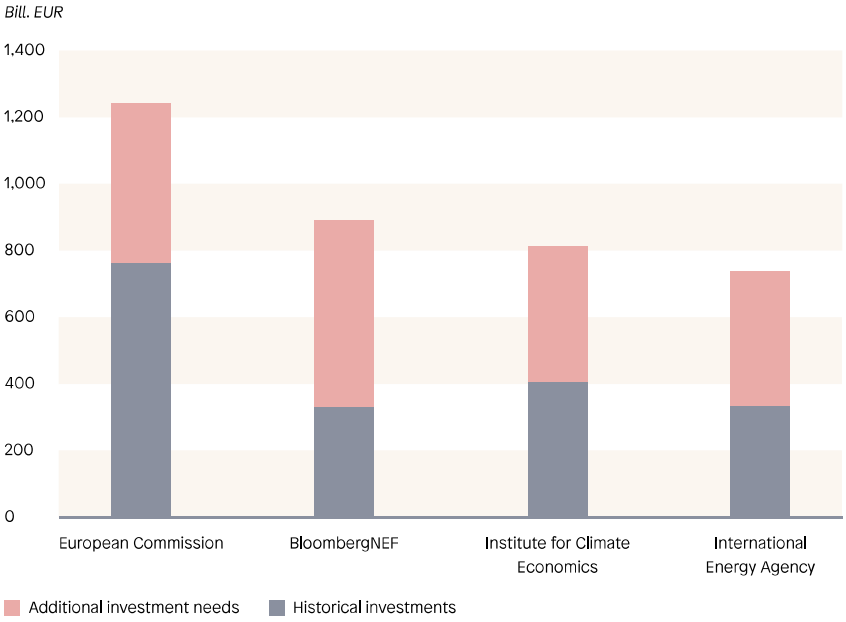

Figure 2 The green transition requires considerable investments

Note 1: The figure shows the total annual investment need in the EU, i.e. the sum of historical investments and additional investment needs. Historical investments refer to annual averages: European Commission (2011–2020), BloombergNEF (2023), the Institute for Climate Economics (2022) and the International Energy Agency (2021–2023).

Sources: Carolin Nerlich et al. 'Investing in Europe's Green Future: Green Investment Needs, Outlook and Obstacles to Funding the Gap', *Occasional Paper Series*, No. 367, European Central Bank, 2025.

rally no shortage of financing. Green investments – like other types of investments – should therefore, in principle, be able to obtain financing, provided they offer a competitive return, i.e. a return similar to that of other investments with comparable riskiness and time horizon.

However, the absence of a price on emissions frequently implies that green investments do not yield a competitive return, as the additional costs of green technologies do not match up with the saved costs for the individual consumer or firm in the form of lower emissions. The consequence is that the return on green investments does not reflect the socioeconomic benefit in the form of reduced emissions. As a result, these investments end up being underfinanced. CO_2e taxation can make green investments more competitive and improve their return, thereby increasing interest from banks and investors in financing green projects. CO_2e taxation is therefore the most important policy tool for financing green investments.

Financial market failures can nevertheless inhibit households and firms from financing green investments, even with a socially optimal CO_2e tax in place. These market failures are additional to the absence of a price on emissions, and they result in underfinancing of green investments. Below, we highlight three financial market failures that are often mentioned in connection with the financing of green investments. The market failures are not specific to green investments, as they also occur in other types of investment.

- Inadequate data about green investments can result in ***asymmetric information***, hindering banks and investors from assessing the risks of these investments. For example, inadequate data about firms' emissions make it difficult to assess the return to investing in greener value chains, e.g. if CO_2e taxes are expected in the future. In addition, many green investments in technology start-ups are made without historical data and financial records, which complicates the risk assessment of these investments.
- Banks and investors tend to operate with ***short-term return requirements***, whereas green infrastructure investments – e.g. power grids and wind turbines – require longer timeframes. If there is a lack of long-term banks and investors, this could result in a mismatch between financing and investment needs, even when investments are assessed to be profitable over the long term.
- ***High start-up costs*** can deter banks and investors from financing otherwise profitable investments because the risk associated with these investments is considered too high. This is especially true in the case of infrastructure investments where the initial financing needs are high.

Does sustainable finance lead to more green investments?

Sustainable finance is typically defined as finance that impose requirements related to the *environmental and climate, social or corporate governance (ESG) conduct of the consumer or firm* investing, in addition to requirements for the financial return.[13,14,15] Climate-related sustainable finance can be interpreted as a correction of climate-related market failures and can thus increase the financing of green investments. Below, we describe the market for sustainable finance. We explore how financing remedies market failures as well as the limitations to sustainable finance.

Sustainable finance presents opportunities and challenges for investors

The global market for sustainable finance grew rapidly from 2018 to 2021, see Figure 3. This expansion reflects an increasing desire among savers – households, firms and funds – to contribute to the green transition. Savers typically have different intentions with supplying sustainable finance, leading to different strategies and criteria for their involvement. Table 1 presents examples of strategies for climate-related sustainable finance.[16]

The market for sustainable finance presents both opportunities and challenges for investors. On the one hand, investors have the opportunity to align their investments with their philanthropic wishes and support sustainable activities. On the other hand, differences in ESG measurement methods and inadequate data make it difficult to assess whether a security truly meets a given sustainability objective, resulting in an opaque market.[17,18,19]

Since 2018, EU reporting requirements have sought to enhance transparency about securities' emission financing and contribution to the green transition. This is achieved through legislation such as the Corporate Sustainability Reporting Directive (CSRD), the Sustainable Finance Disclosure Regulation (SFDR) and the Taxonomy Regulation (TR). These requirements lead to better data about green investments and make it easier to evaluate their return. In principle, the requirements should reduce the degree of asymmetric information and increase the financing of green investments.

There is an ongoing debate about the balance between transparency and the bur-

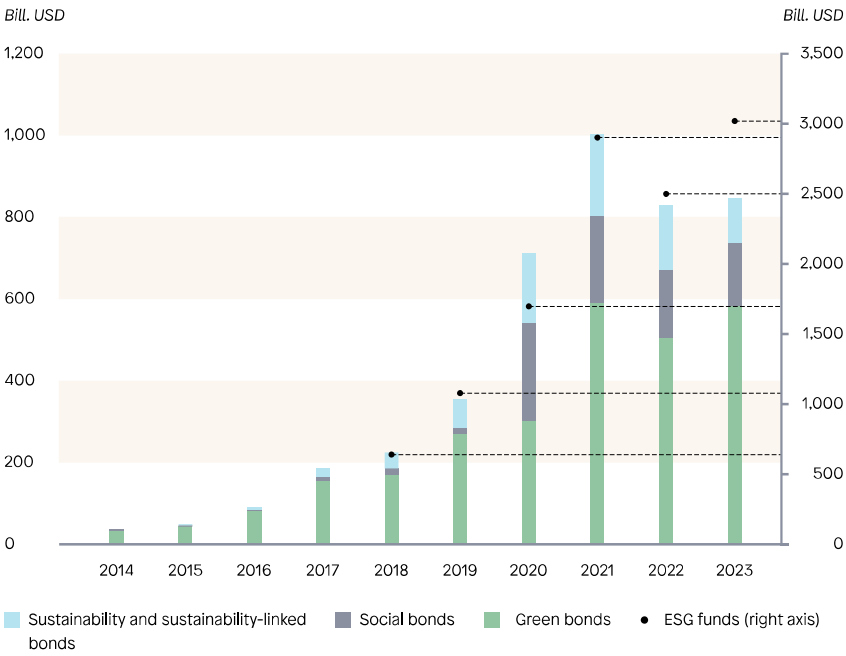

Figure 3 The market for sustainable finance grew from 2018 to 2021

Note 1: The columns show green, social, sustainability and sustainability-linked bond issuances since 2014. The dots show the market value of assets managed by investment funds with explicit mandates for sustainable investment.

Sources: Climate Bonds Initiative (bonds) and Carolin Nerlich et al., 'Investing in Europe's Green Future: Green Investment Needs, Outlook and Obstacles to Funding the Gap', *Occasional Paper Series*, No. 367, European Central Bank, 2025 (ESG funds).

Strategy	Description
Green bonds	Bonds issued to finance typically larger green projects, e.g. development of solar and wind energy
Green loans	Loans targeting green projects in households and firms, e.g. energy renovations or the purchase of EVs
Exclusion / negative screening	Exclusion of investments in companies that do not meet climate-related criteria, e.g. concerning the extraction and use of fossil fuels
Positive / best-in-class screening	Investment in firms that perform best in their industry on environmental and climate criteria
Active ownership	Direct engagement with companies to influence their sustainability strategies and reduce CO_2e emissions
Impact investing	Investment in firms to generate both financial returns and a measurable positive climate impact
Blended finance	Combination of public and private financing, where the public funds reduce the risk and make green investments more attractive to private investors.

Table 1 Examples of climate-related sustainable finance strategies

Sources: Organisation for Economic Co-operation and Development, 'OECD Business and Finance Outlook 2020: Sustainable and Resilient Finance', 2020 and Network for Greening the Financial System, 'Sustainable and Responsible Investment in Central Banks' Portfolio Management', 2024.

den of reporting requirements. Specifically, the discussion focusses on whether the benefits of more robust data and transparency align with the administrative costs of reporting.[20] The outcome of this debate will impact future reporting requirements.

Sustainable finance can remedy financial market failures and amplify the impact of CO_2e taxation

Sustainable finance can remedy financial market failures in different ways, depending on the market failure in question. Since financial market failures are not unique to green investments, there are already public and private institutions

that support such investments. The financing of green investments, which CO_2e taxation makes profitable, increases when financial market failures are remedied, amplifying the effect of the taxation.[21,22]

Public authorities can finance large start-up costs and prioritise long-term returns over short-term return requirements in public-private partnerships, such as green infrastructure investments. Similarly, *public funds* and *development banks* can reduce the risk for private banks and investors in green investments, e.g. by financing start-up costs through loans, guarantees, capital contributions and blended finance. This absorbs part of the initial risk of the investments and makes it more attractive for private actors to participate in the financing.[23] Examples of funds and development banks include the Export and Investment Fund of Denmark and the European Investment Bank.

Private pension companies also have the potential to finance green investments with large start-up costs and long-term returns. Pension companies themselves have long-term obligations to their customers, since they must secure pensions for decades in the future. In addition, *private venture capital* and *impact investors* can improve access to financing for green technology start-ups that struggle to attract capital due to insufficient historical financial records and high technological risks. Green venture funds specialise in investing in innovative firms with considerable growth potential, even when traditional banks and investors assess the risk as being too high. Similarly, impact investors may be willing to accept more riskiness if the investment has a positive climate impact.

Finally, it is worth noting that public authorities can support green infrastructure investments through means beyond finance. For example, the expansion of offshore wind farms was underpinned by guarantees of a minimum settlement price over a number of years.[24] Similarly, the development of power-to-X technologies relies crucially on public initiatives, including the establishment of hydrogen infrastructure that facilitates exports to, among other countries, Germany.[25]

Sustainable finance can partially emulate the effects of CO_2e taxation

In addition to remedying financial market failures, sustainable finance can incentivise the green transition if it makes the financing of green activities cheaper or increases the cost of financing polluting activities. The difference in financing conditions between green and polluting activities will, in principle, emulate the effect

of CO_2e taxation by encouraging consumers and firms to reduce their emissions to obtain better financing conditions.

However, it remains uncertain whether conventional strategies for sustainable finance in practice create sufficiently large differences in financing conditions so that this, in itself, promotes green investments. Sustainable finance is often implemented by excluding loans and investments in high-emission firms, such as coal and oil firms. In principle, this should lead to lower financing costs for green activities and more expensive financing for polluting activities. Research suggests, however, that it is uncertain whether sustainable finance generally achieves this to an extent that can drive the transition.[26,27,28,29,30] For example, if a pension fund sells shares in a polluting firm, other investors who are focused solely on returns may purchase the shares at roughly the same price, merely resulting in a change in ownership that does not affect the firm's incentives.

What tools can promote sustainable finance, and can green monetary policy play a role?

Authorities can promote the supply of sustainable finance through various fiscal, tax and business policy tools.[31] For example, the 2020 Green Tax Reform introduced greater tax deductions for corporate green investments.[32] Turning to industrial policy, the 2025 Entrepreneurship Agreement increases the amount of capital available for the Export and Investment Fund of Denmark to invest in green start-ups.[33]

It is important to take state aid rules and industrial policy into consideration if authorities wish to promote sustainable finance. Since green energy and infrastructure projects often have an international dimension, it may be appropriate to coordinate public sustainable finance with other countries. In recent reports, the IMF points out that strategic finance should be targeted to specific market failures and that it should be temporary in order to avoid market distortion and ensure fair competition.[34,35,36] Similarly, the EU's Competitiveness Compass emphasises that strategic investments in green technology must be balanced with the aim of an open and competitive market.[37]

Danmarks Nationalbank ensures stable economic and financial conditions for the green transition

The most important contribution of Danmarks Nationalbank to the green transition is to ensure stable economic and financial conditions for the transition. Danmarks Nationalbank's objectives are to contribute to stable prices, secure payments and financial stability in Denmark. Reaching these objectives provides consumers, firms and policymakers with the stability to make long-term plans and investments into a greener future.

For several years, climate change has been a key issue at Danmarks Nationalbank, just as it has been for other European central banks. This is because climate change and the green transition may challenge the objectives of price and financial stability. We therefore investigate climate-related losses and risks to the economy and financial system. The purpose of this work is to provide recommendations to relevant authorities and the financial sector on how to manage the losses and risks. Since 2021, a key recommendation has been that the transition can be achieved in a cost-effective manner, and with the lowest level of risk to price and financial stability, in the Danish economy through a uniform CO_2e tax.[38] This recommendation is in line with recommendations from the Council on Climate Change and the Economic Councils.[39,40]

Furthermore, Danmarks Nationalbank – acting in its role as government debt manager – contributes to the market for sustainable finance by issuing green bonds on behalf of the Ministry of Finance. The proceeds from the sale of these bonds cover green government expenditures. As government debt manager, these issuances serve two purposes: First, the issuances contribute to developing financial markets by setting a standard for the Danish green bond market. Second, the issuances contribute to maintaining a broad and diversified investor base in the Danish government bond market.

It should also be noted that, since 2021, Danmarks Nationalbank has taken climate factors into consideration in its foreign exchange reserve when investing in equities and corporate bonds through exchange-traded funds (ETFs). This decision aligns with our guidelines for responsible investing, which stipulate that we do not buy shares and bonds in firms and countries that are systematically and substantially involved in activities that Denmark dissociates itself from through international guidelines, declarations, conventions, etc. This includes, among other things, Denmark's accession to the Paris Agreement. The approach for equities and corporate bonds is in line with recommendations of the Network for Greening the

Financial System regarding the climate-related investments of central banks.[41]

Green monetary policy has been suggested as a policy to promote sustainable finance. The policy could involve Danmarks Nationalbank offering higher interest rates on deposits to banks that extend green loans to consumers and firms, serving as an incentive to promote green lending. This would imply a differentiation of Danmarks Nationalbank's interest rates to banks based on climate-related targets for bank lending. As we describe below, such a policy would not offer any benefits over CO_2e taxation or public subsidies for sustainable finance. Moreover, the policy can have negative consequences. For this reason, neither the European Central Bank nor any other central bank in countries we normally compare ourselves with, provide green loans to banks. Likewise, we do not believe that a green monetary policy would be appropriate in Denmark. The negative consequences apply in various areas:

First, *green monetary policy is equivalent to subsidies and taxes on banks in its impact on the government budget and banks' incentives*, hence should be subject to an open political process. If Danmarks Nationalbank were to provide better loan terms for particularly green banks, this would constitute a form of subsidy. The cost for Danmarks Nationalbank will impact the profit that Danmarks Nationalbank transfers to the government. Similarly, if Danmarks Nationalbank were to provide worse terms for banks that lend to high-emission projects, this would be a punitive taxation of these banks. In both cases, the policy would have the same consequences for the government budget – and thus for taxpayers – as direct subsidies or taxes on banks. Since such subsidies and taxes equal fiscal and tax policy, they should be enacted as such by elected politicians and reflect transparent political priorities that are communicated to the public. For example, a public investment fund would be able to implement the subsidies with the same effect, but with full transparency regarding decisions and costs.

Second, *the fixed exchange rate policy limits the ability of Danmarks Nationalbank to differentiate its monetary policy interest rates*. Danmarks Nationalbank's interest rates are currently set solely to ensure a stable exchange rate vis-à-vis the euro. It is incompatible with the fixed rate policy to substantially adjust interest rates to achieve climate objectives. Any such policies would therefore need to be limited in scope, and it would require a costly administration and willingness to risk disrupting the foreign exchange market.

Third, *green monetary policy may compromise the credibility and independence of Danmarks Nationalbank*. There is no widely accepted and objective definition of

green activities. Support for green investments has distributional consequences. And there are different political views on whether the green transition should be supported and which parts of society should bear the cost. Green monetary policy can therefore lead to political pressure to influence Danmarks Nationalbank's decisions. History shows that central banks operating independently of political interests are the best safeguards of a stable economy.[42] That is precisely why the principle of independent central banks is enshrined in the Treaty on the Functioning of the European Union.[43]

Conclusion

The climate crisis has been described as 'the greatest market failure the world has ever seen'.[44] Economists typically focus on the absence of a price on emissions when describing market failures. However, there are also financial market failures present, as this chapter describes. In addition, research describes how political and economic dynamics prevent sufficient CO_2e taxation from being adopted.[45] Together, these factors counteract the green transition globally.

Financial market failures are caused by asymmetric information on green investments, short-term return requirements in the financial sector and the high start-up costs of green investments. Sustainable finance can address these market failures by offering targeted financing for green investments, although sustainable finance cannot fully replace CO_2e taxation.

Since 2018, the market for sustainable finance has grown, and authorities can further promote its supply through fiscal, tax and industrial policies. The most important contribution of Danmarks Nationalbank to the green transition is to ensure stable economic and financial conditions that support long-term planning and investment.

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